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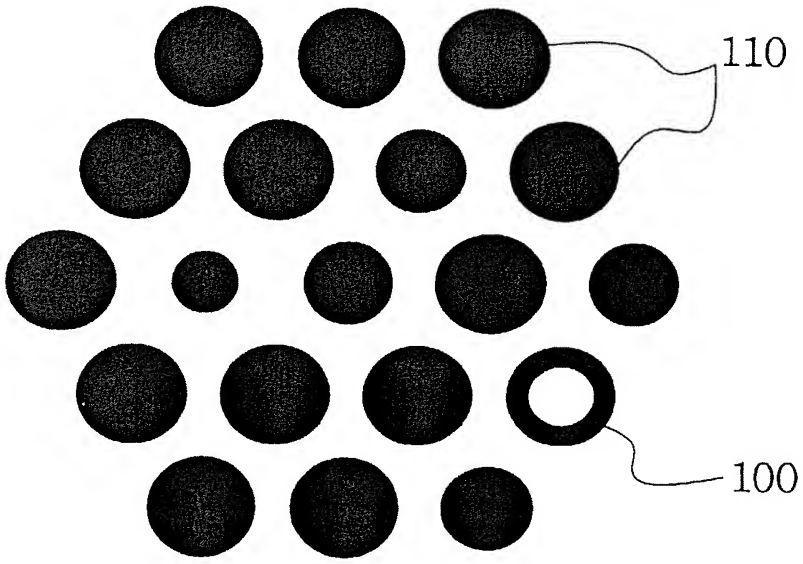
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: CODED PATTERN AND METHOD FOR THE EXTRACTION OF CODE FROM THE SAME



(57) Abstract: A coded pattern and a method for extracting the codes from the same are disclosed, in which images are obtained by a camera to recognize them, and codes are extracted from the obtained images. A plurality of symbols as constituents of the coded pattern respectively have circular structures and various code values, and the symbols lie within a 2-dimensional lattice structure. The code values are decided by the sizes of the symbols. The lattice structure consists of a combination of lattices, and each of the lattices ranges from a triangular form of a polygonal form. Each of the symbols has a center at each of the corners of the lattice structure. The centers of the symbols are equidistantly arranged with the centers of the adjacent symbols.

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CODED PATTERN, AND METHOD FOR EXTRACTION OF CODES FROM THE SAME

FIELD OF THE INVENTION

The present invention relates to a coded pattern and a method for extracting the codes from the same, in which images are obtained by a camera to recognize them, and codes are extracted from the obtained images.

BACKGROUND OF THE INVENTION

Generally, there are the following code patterns from which codes can be extracted after obtaining the images by a camera or a scanning means. That is, there are 2-dimensional bar codes such as maxicode, data matrix, code one, Vericode, codablock, array tag, Phillipse dot code, soft strip code, and QR code.

These 2-dimensional bar codes are widely used in the industrial fields and in the everyday life. The typical application is their use in supermarkets for improving the management efficiency and for recording the inventory.

Further, the 2-dimensional bar codes are used in various documents for labeling them, and they are also used for confirming the move of the postal articles.

However, the 2-dimensional bar codes take the form of bars or rectangular shapes, and therefore, the shape distortions are severe for the motions, inclinations and defocus, so that errors are apt to occur.

If the information of the bar code shape is to be obtained by a camera, and if the codes are to be extracted, then a high resolution camera has to be used, and particularly, the use of the bar codes may be refused due to religious creeds.

SUMMARY OF THE INVENTION

The present invention is intended to overcome the above described disadvantages of the conventional technique.

Therefore, it is an object of the present invention to provide a coded pattern in which the respective symbols have a circular graphic, have

different code values depending on the size of the symbols, and lie within a certain lattice structure.

It is another object of the present invention to provide a method for extracting the codes from the coded pattern, in which an image of the coded pattern is obtained, and codes are extracted by recognizing the obtained pattern.

In achieving the above objects, the coded pattern according to the present invention is characterized in that: a plurality of symbols as constituents of the coded pattern have circular structures and various code values; and the symbols lie within a 2-dimensional lattice structure.

The code values are determined in accordance with the sizes of the symbols.

The lattice structure consists of a combination of lattices ranging from a triangular form to polygonal form.

The centers of the respective symbols lie at the corners of the lattice structure.

The centers of all the symbols are equidistantly arranged.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and other advantages of the present invention will become more apparent by describing in detail the preferred embodiments of the present invention with reference to the attached drawings in which:

FIG. 1 illustrates an example of the coded pattern according to the present invention;

FIG. 2 illustrates a state in which the code symbols of the present invention lie in a regularized lattice structure;

FIG. 3 illustrates an example of the code symbols in which their sizes are different from each other;

FIG. 4 illustrates an example of the sequence in which the codes are recorded starting from a base symbol;

FIG. 5 illustrates an example of the code values which are decided by the sizes of the code symbols;

FIG. 6 illustrates an apparatus for extracting the codes from the coded pattern of the present invention;

FIG. 7 illustrates the method for extracting the codes from the coded pattern of the present invention;

FIG. 8 illustrates the procedure for detecting the circular cluster; and

FIGs. 9 to 11 illustrate various examples of the coded patterns according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The coded pattern according to the present invention will be described in detail referring to FIGs. 1 to 5.

FIG. 1 illustrates an example of the coded pattern according to the present invention. Respective symbols 110 having respective code values are provided in the number of at least more than one. The respective symbols have a circular shape.

The reason why the respective symbols 110 have the circular shape is as follows. That is, the circular shape is strong against the motion distortions which are caused by the hand vibrations during the image collection by means of an image obtaining means such as a camera or a scanner. Further, it is also strong against the inclination angle distortions during the obtaining of the 2-dimensional pattern image from all the four sides. Further, it is also strong against the shape distortions caused by defocus. Particularly, under the inclination distortion, a correction can be easily carried out.

The respective symbols 110 with the circular form are arranged in a form of a lattice structure 120 with a certain regularity as shown in FIG. 2. The reason why the triangular lattice structure is adopted is that the centers 130 of the respective circular symbols can be equidistantly maintained, and therefore, the largest number of symbols can be accommodated within a certain area.

Under this condition, the lattice structure can consist of a combination of triangles or more angles such as tetragonal, pentagonal and the like.

Further, spaces are allowed between the symbols 110, and all the spaces are connected to each other with a certain regularity. Accordingly, they can be easily separated from the background.

In this context, it is apparent that the number of the codes of the corded pattern can be very much increased by expanding the lattice structure and by increasing the number of the symbols.

The base symbol 100 is circular but empty so as to be ring-shaped unlike the other symbols 110, and this base symbol 100 becomes a criterion position for extracting the codes.

The position of the base symbol 100 can be varied by a predetermination, and its shape can also be varied to whatever form.

FIG. 3 illustrates that the respective symbols 110 can have different code values depending on the size of the diameter. Here, three examples are shown.

That is, the largest symbol has a value of '9', and the medium-sized symbol has a value of '7', while the smallest symbol has a value of '5'. Thus all of them have their own unique values.

The values 9, 7 and 5 are not themselves the code values, but show the size.

FIG. 4 illustrates an example in which the respective symbols 110 of the coded pattern are arranged starting from the base symbol 100. That is, adopting the base symbol 100 as the starting point, the symbols 110 with a series of code values are arranged anticlockwise by making the symbols 110 advance toward the symbol No. 18 in a spiral form.

This is just an example, and therefore, the arrangement shape can be varied by a pre-agreement to whatever form.

FIG. 5 illustrates a state in which the code values of the respective symbols 110 are extracted in the arranged order.

It is assumed as follows. That is, the largest symbol with a radius value of '9' has a code value '2', and the medium-sized symbol with a radius value of '7' has a code value of '1', while the smallest symbol with a radius value of '5' has a code value of '0'.

In this context, if the sizes of the respective symbols are diversified more, then the code values can be more diversified.

The code values which have been extracted in the arranged order is '1 2 2 2 2 2 2 2 2 1 2 2 1 2 0 2 1'. This is a ternary number, and therefore, if it converted into the binary value, it becomes a bit stream of '001 010 010 010 010 010 010 010 010 001 010 010 001 010 000 010 001'.

Accordingly, this binary bit stream will become a meaningful data later.

To take just an example, if the coded symbols of the present invention are printed on a movie poster, and if a user obtains the pattern image by using a camera (or web camera, or a camera of an IMT terminal) or a scanner, then the codes can be extracted from the image. If the data of the codes represents a domain address of a web site, then directly the site can be connected to obtain or search the movie information such as the title, the main actors, the movie duration time, the abstract of the movie story and the like. This data can be downloaded and displayed.

To take another example, if the coded pattern has been applied on an apparatus which is to be controlled, then the pattern image can be obtained, and the codes can be extracted. Thus a control command list for the apparatus can be downloaded from a remotely located server.

That is, if the coded pattern has been applied on a television, then a control command list can be downloaded to a terminal.

Thus if the user selects a particular command, the remotely located server furnishes the relevant control command to the home server, and the home server can supply the control command to the relevant apparatus.

Thus a desired data can be downloaded from a remote place by utilizing the coded pattern of the present invention, or a particular control can be carried out on a particular object.

The application field of the present invention is not limited to this, but can be expanded or varied to whatever degree or to whatever form.

Meanwhile, the method for extracting codes by recognizing a coded pattern according to the present invention includes the steps of: trimming a

pattern image after obtaining it by using an image obtaining means (pre-processing step); carrying out a segmentation and cluster merging step; interpreting a scale invariant momentum of each of the merged clusters to detect circular designs (circular design detecting step); searching for bundles of mutually connected adjacent circular designs (connected within a certain size of radius), for grouping the bundles after detecting the circular designs at the preceding step (circular cluster detecting step); judging as to whether the detected circular clusters are positioned within a lattice structure, and estimating the sizes of respective circular clusters (symbol size and position estimating step); regularizing the sizes of the symbols into a most desirable ones based on a probability calculation, and classifying them into n classes based on the sizes (classifying step); and extracting code values from the symbols after classifying them into the n classes in accordance with the sizes of the symbols based on a certain rule (code extracting step).

Now the present invention constituted as above will be described in detail as to its method for extracting codes from the coded pattern referring to FIGs. 6 to 9.

First, if the image of the coded pattern is obtained by an image obtaining part 200 which consists of a camera or a scanner, then the processor 210 receives the obtained image to carry out a preprocessing (ST300 and ST310).

Under this condition, if the image obtaining part 200 is a web camera, the processor 210 can be installed within a computer. If the image obtaining part 200 is an IMT terminal, then the processor 210 can be installed within the terminal.

Further, the processor 210 can contain a pattern recognizing program, so that the pattern recognizing procedure can be carried out.

This preprocessing step ST310 is carried out to suppress or remove the defocusing, the motion distortion and the noise.

Generally, the image restoration is carried out to improve the picture quality by removing the noises from the images or by improving the blurring of the images. That is, the image restoration makes it possible to obtain an

information which cannot be obtained directly.

The blurring of an image occurs when the camera or the object moves, or when the focusing is not precise. The noises occur by an electrical cause, or by a problem in the homogeneity of the CCD cells, or by the finite size of the CCD cells or by their finite sizes when digitizing them.

Such an image can be effectively restored based on the known Richardson-Lucy method.

Further, the image distortions due to the hand vibrations and the like can be effectively corrected by the known Kalman filter.

In order to remove the background noise, the median filter is used, and this filter is the one in which the edge blurring degree is minimal when extracting the circular designs from the image. The code symbols of the coded pattern according to the present invention have a circular structure, and therefore, the median filter can be preferably used.

The use of the median filter is carried out in the following manner. That is, the mean value of the values of the adjacent pixels is calculated at a given point, and the mean value is replaced with a pixel value of the present position. Thus the noises which occur in the areas other than the circular symbol can be removed.

The median filter can most effectively cope with the images which occur in a spike form.

The processor 210 carries out a segmentation step (ST320) after the preprocessing step (ST310). At this step, in order to analyze the geometrical information such as size, shape and position in the respective regions of the image, there is employed the known connected component labeling method.

In this method, the portions which do not require the attention are deleted, and the major regions are sequentially labeled and analyzed.

That is, the threshold values of the similar colors are decided, and if the similar chromatic values of the respective pixels come within the threshold value, then the same labels are assigned. Thus the pixels having the same labels are clustered, thereby carrying out the segmentation.

Thereafter, the processor 210 carries out a cluster merging step.

(ST330) by adopting the well known Pedro's method.

In this method, if the measure of colors of the pixels, which has been given a meaning at the segmentation step ST320, is smaller than the threshold value, then the pixels are bundled into a cluster, and otherwise, the bundling is not carried out.

Through this procedure, clusters each consisting of a plurality of pixels will be formed.

After carrying out the cluster-merging step ST330, the scale invariant momentum for each of the clusters is interpreted. In this procedure, first the invariant momentum which is not related to the rotation, movement and the size of the scale is calculated for each of the clusters.

This momentum is defined by Formula 1 as shown below.

<Formula 1>

$$\mu_{pq} = \sum_{x}\sum_{y}(x-\bar{x})^{p}(y-\bar{y})^{q}$$

Further, the regularized momentum, i.e., the centralized momentum is defined by Formula 2 as shown below.

<Formula 2>

$$\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}^{\gamma}}$$

where $\gamma = \frac{p+q}{2} + 1$

Thereafter, a circular shape detecting step ST350 is carried out. That is, the momentum invariant is calculated from Formulas 1 and 2 in which all the points in a cluster are covered. This momentum invariant is

defined by Formula 3 as shown below.

<Formula 3>

$$\phi_1 = \eta_{20} + \eta_{02}$$

$$\phi_2 = (\eta_{20}-\eta_{02})^2 + 4\eta_{11}^2$$

$$\phi_3 = (\eta_{30}-3\eta_{12})^2+(3\eta_{21}-\eta_{03})^2$$

$$\phi_4 = (\eta_{30}+\eta_{12})^2+(\eta_{21}+\eta_{03})^2$$

In the above formula, the circular shape $\phi_1 = \Pi$, and above ϕ_2 is 0. If elliptically projected by an inclination, then ϕ_2 is about 2, and above ϕ_{13} is 0.

If the circular designs are detected to a number of n at the circular shape detecting step ST350, then a circular shape cluster detecting step ST360 is carried out. At this step, the bundles which are interconnected between the adjacent circular designs within a certain radius are detected for the respective circular designs which have not given a meaning as code symbols so far.

For the given circular designs, the scales of the radius are gradually varied from the allowable minimum size to the maximum size, and in this manner, the centers of the adjacent circular designs are compared with each other, thereby judging the connection state.

That is, as shown in FIG. 8, if the centers of the circular designs are present within the allowable radiuses (i.e., 5, 7 and 9), then the adjacent circular designs are bundled into a cluster.

Ultimately, this cluster becomes code symbol, and a plurality of clusters of the circular designs become the coded pattern of the present invention.

If a plurality of clusters of circular designs are detected at the cluster detecting step ST360, then a base symbol is detected at a step ST370. The base symbol has an annular shape, and therefore, the symbol which is empty, that is, which is digitally 0 is decided as the base symbol.

If the circular distribution and the base symbol are decided at the preceding steps, then a judgment is carried out as to whether the circular

designs around the base symbol are positioned within the lattice structure. Thus the meaningful symbols as codes are searched (step ST380).

That is, as shown in FIG. 2, if the centers of the adjacent circular clusters are positioned in the regular triangle around the base symbol, then the circular clusters at that position are decided as the symbols, and the sizes of the symbols are decided advancing from the center of the decided circular cluster to the outside boundary based on the radius.

However, the sizes of the decided symbols, i.e., the radiuses of the decided symbols are not exactly 9, 7 and 5, (but for example, 9, 3, 7, 6, 5, 2 and the like). Therefore, if they are adopted as the code symbols as they are, then errors may occur.

Therefore, a step ST390 is carried out at which the symbols are classified into n classes (in the present invention, they are 3 symbols consisting of 9, 7 and 5).

That is, in an ideal case, the radiuses of the symbols are 9, 7 and 5, but if they are actually applied to images, the same accurate ratio cannot be seen but intermediate sizes can occur. Therefore, there are difficulties in interpreting them mechanically.

Therefore, the known statistical method, i.e., the EM (expectation maximization) method is employed so that the most promissory boundary values can be obtained to regularize them into three classes.

Thus, if the coded pattern of FIG. 1 is recognized through the steps ST300 – ST380, then the codes which becomes meaningful by their radiuses are extracted based on the arranged sequence starting from the base symbol 100 as shown in FIG. 4 (ST390).

The code extraction order data may have been stored in the memory 220, but the extraction order can be varied to whatever form.

That is, as shown in FIG. 5, the values of '1 2 2 2 2 2 2 2 2 2 1 2 2 1 2 0 2 1' are extracted by the processor 210. These are ternary values, and therefore, they are outputted in a form of bit stream after converting them into binary values of '001 010 010 010 010 010 010 010 010 010 001 010 010 001 010 000 010 001'.

FIGs. 9 to 11 illustrate other forms of the coded pattern according to the present invention. In the case of FIG. 9, the coded pattern is shaped in a form of 'A'.

Here also, the respective symbols are positioned within the lattice structure.

In the case of FIG. 10, the coded pattern is shaped like a telephone apparatus, while in the case of FIG. 11, the coded pattern is shaped like a television.

Thus diversified coded patterns can be formed by varying only the positions of the symbols within the lattice structure.

According to the present invention as described above, the information of the symbol which is a constituent of the pattern is decided by the size of the circular design, and the symbols are positioned within the lattice structure. Accordingly, the following results can be reaped.

(1) Each of the symbols has a circular basic design, and therefore, the distortions of the images are very low.

(2) The vacant spaces between the respective symbols are all connected together, and therefore, the symbols can be easily separated from the background.

(3) The pattern can be variously embodied in a shape of a letter, a telephone apparatus, a television or the like, and thus, the aesthetics of the pattern can be improved. Accordingly, the coded pattern of the present invention can be applied to a field where the bar codes are disliked.

(4) The pattern can be analyzed with a low resolution camera, and therefore, the cost of the image obtaining means can be curtailed.

(5) The pattern is resistant against noises, and therefore, the picture quality can be improved when it is applied to motion pictures such as television programs, movies or the like.

WHAT IS CLAIMED IS:

1. A coded pattern characterized in that:

a plurality of symbols as constituents of the coded pattern respectively have circular structures and various code values; and

the symbols lie within a 2-dimensional lattice structure.

2. The coded pattern as claimed in claim 1, wherein the code values are decided by sizes of the symbols.

3. The coded pattern as claimed in claim 1, wherein the lattice structure consists of a combination of lattices, each of the lattices being ranging from a triangular form to a polygonal form.

4. The coded pattern as claimed in claim 1, wherein each of the symbols has a center at each of the corners of the lattice structure.

5. The coded pattern as claimed in claim 1, wherein the centers of the symbols are equidistantly arranged with the centers of the adjacent symbols.

6. A method for extracting codes by recognizing a coded pattern, comprising the steps of:

trimming a pattern image after obtaining it by using an image obtaining means (pre-processing step);

carrying out a segmentation and a cluster merging (segmentation and cluster merging step);

interpreting a scale invariant momentum of each of the merged clusters to detect circular designs (circular design detecting step);

searching for bundles of mutually connected adjacent circular designs (connected within a certain size of radius), for grouping the bundles after detecting the circular designs at the preceding step (circular cluster detecting step);

judging as to whether the detected circular clusters are positioned within a lattice structure, and estimating sizes of the respective circular clusters (symbol size and position estimating step);

regularizing the sizes of the symbols into a most desirable ones based on a probability calculation, and classifying them into n classes based on the sizes (classifying step); and

extracting code values from the symbols after classifying them into the n classes in accordance with the sizes of the symbols based on a certain rule (code extracting step).

7. The method as claimed in claim 6, wherein the lattice structure consists of a combination of lattices, each lattice being ranging from a triangular form to a polygonal form.

8. The method as claimed in claim 6, wherein each of the circular clusters has centers at corners of the lattice structure.

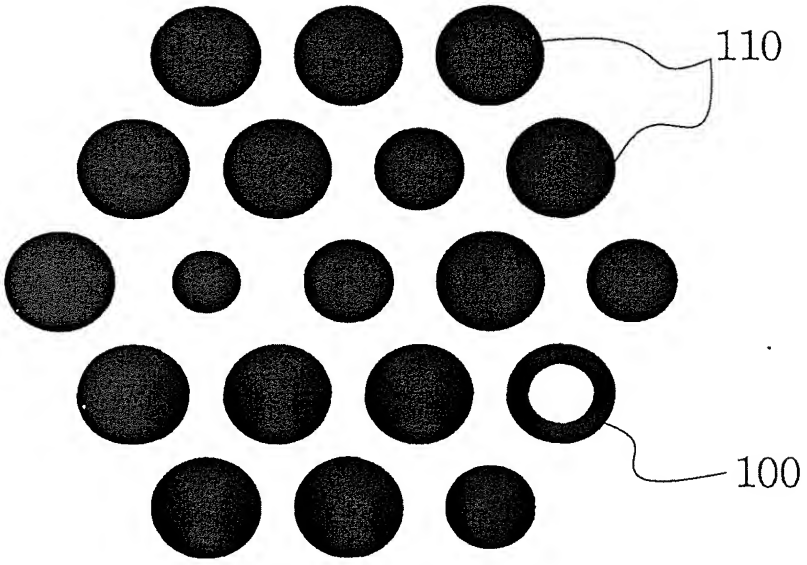

FIG. 1

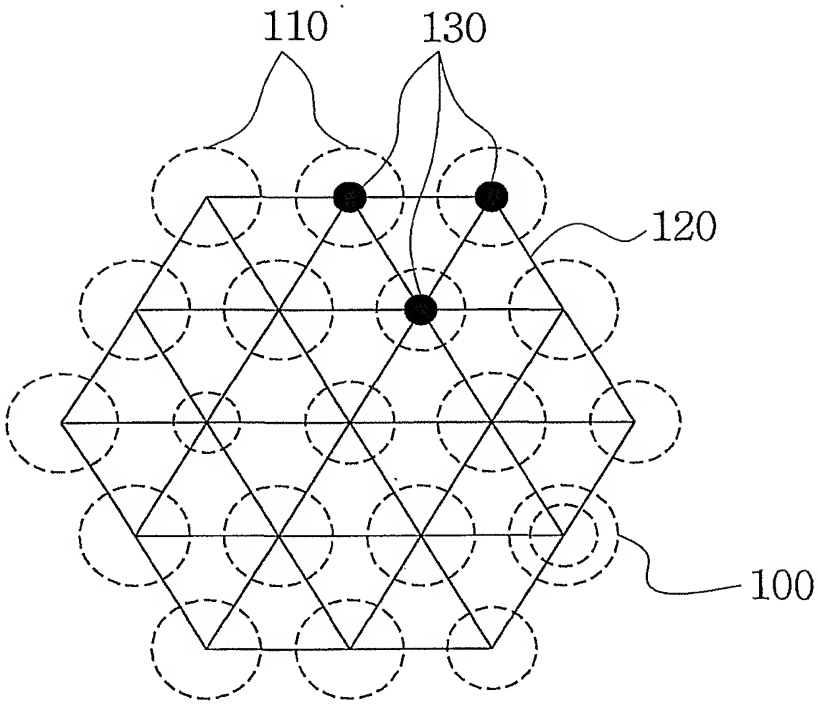

FIG. 2

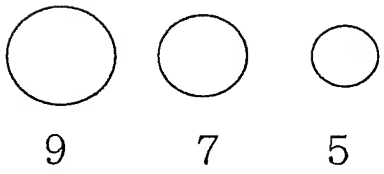

FIG. 3

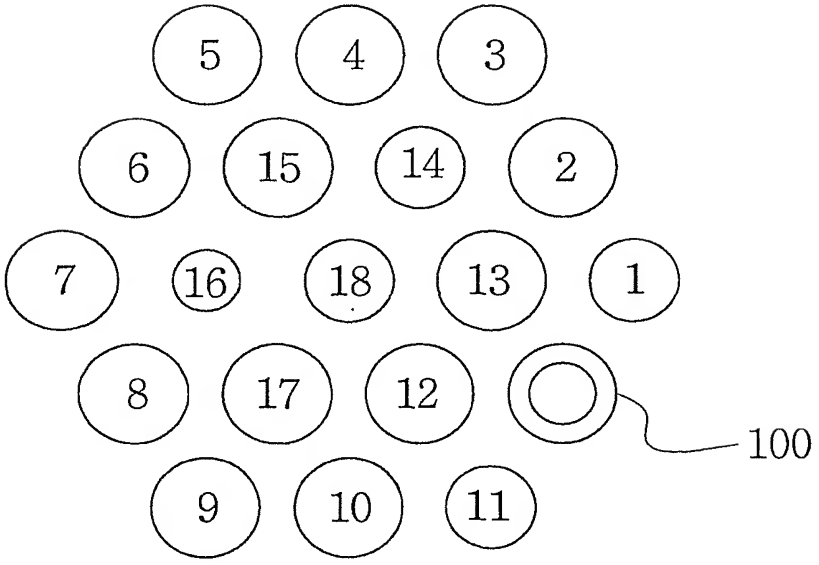

FIG. 4

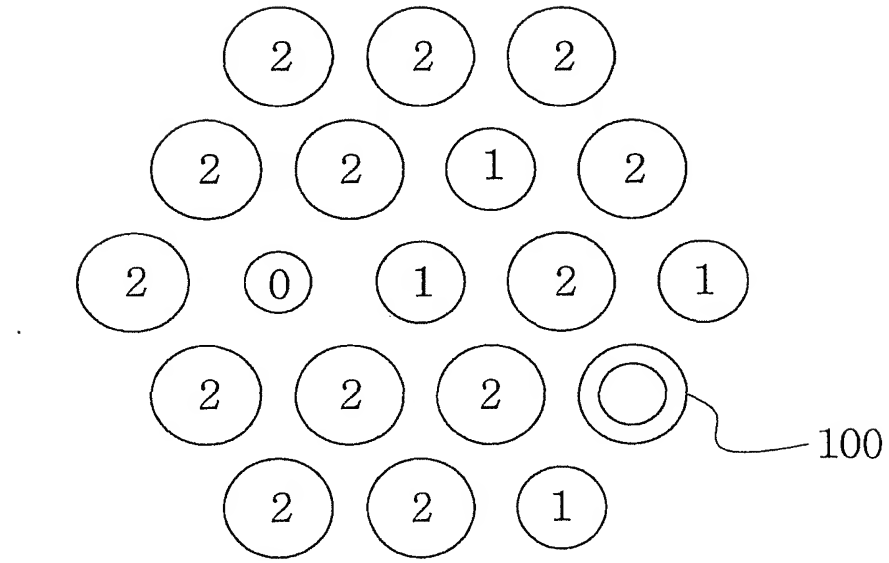

FIG. 5

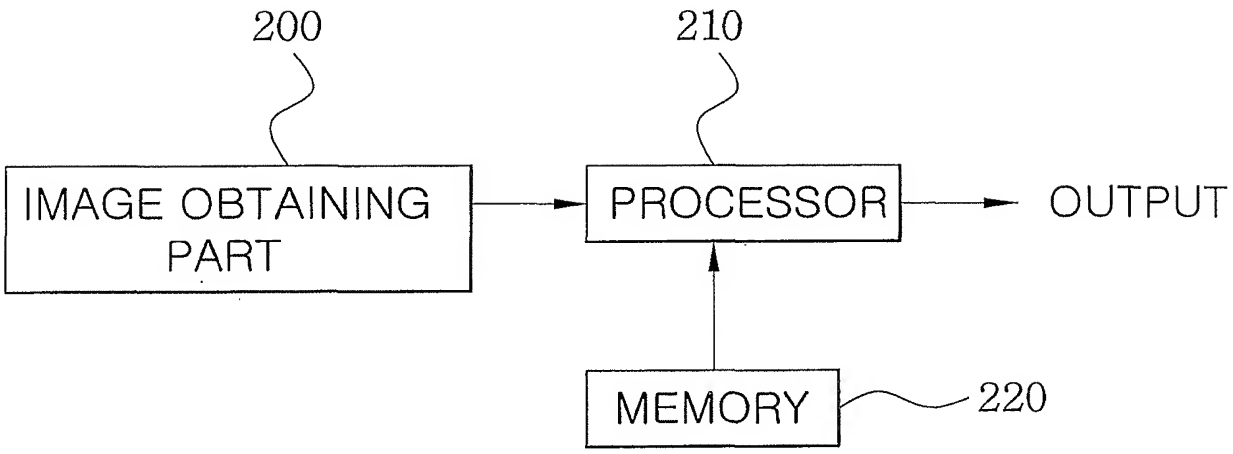

FIG. 6

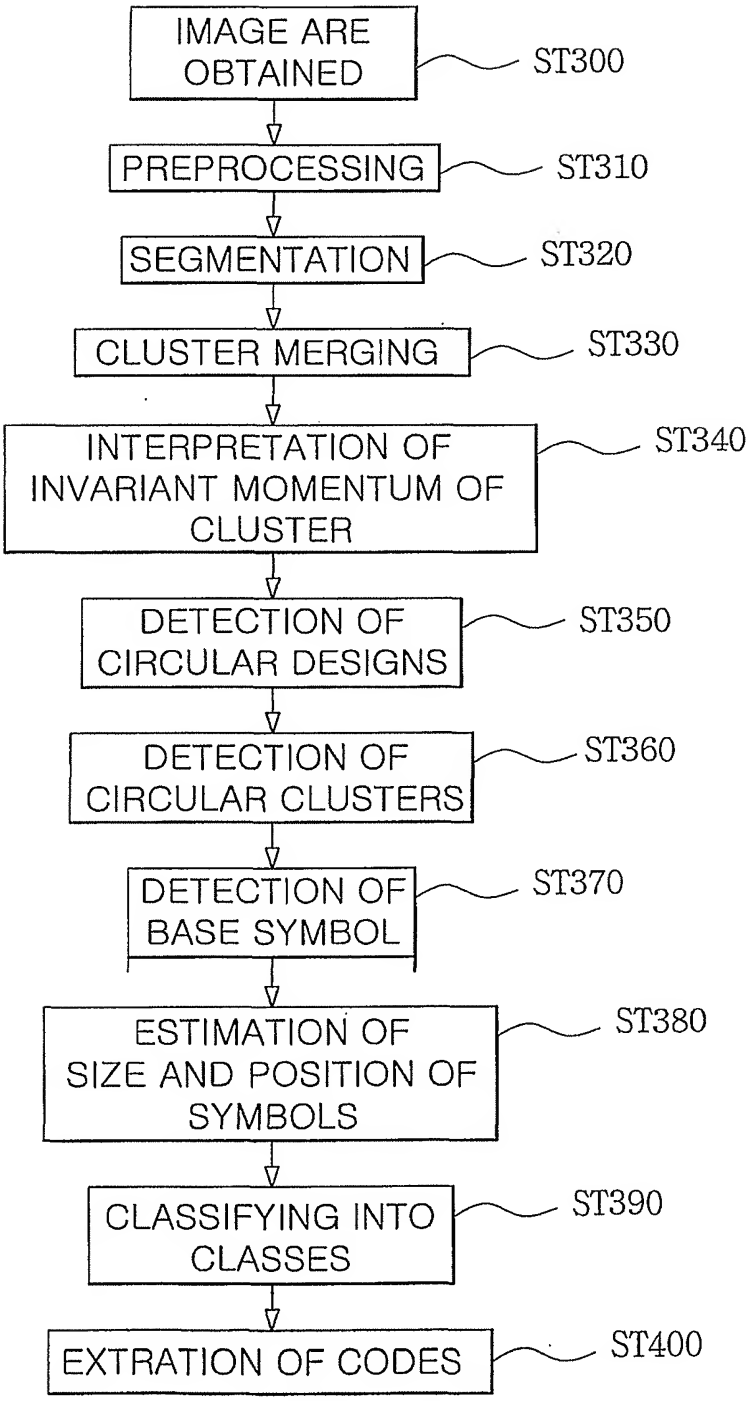
IMAGE ARE OBTAINED
ST300
PREPROCESSING
ST310
SEGMENTATION
ST320
CLUSTER MERGING
ST330
INTERPRETATION OF INVARIANT MOMENTUM OF CLUSTER
ST340
DETECTION OF CIRCULAR DESIGNS
ST350
DETECTION OF CIRCULAR CLUSTERS
ST360
DETECTION OF BASE SYMBOL
ST370
ESTIMATION OF SIZE AND POSITION OF SYMBOLS
ST380
CLASSIFYING INTO CLASSES
ST390
EXTRATION OF CODES
ST400

FIG. 7

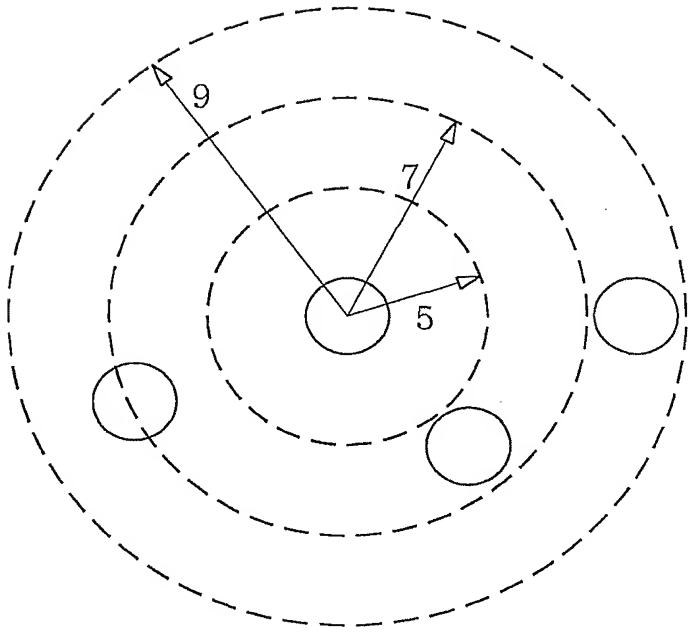

FIG. 8

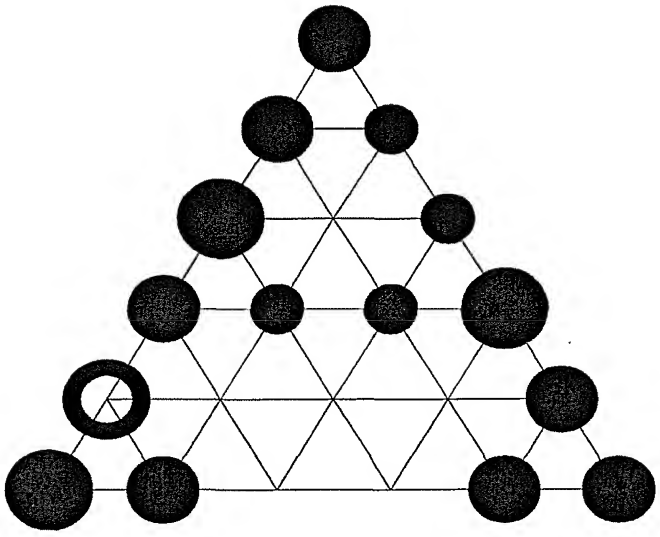

FIG. 9

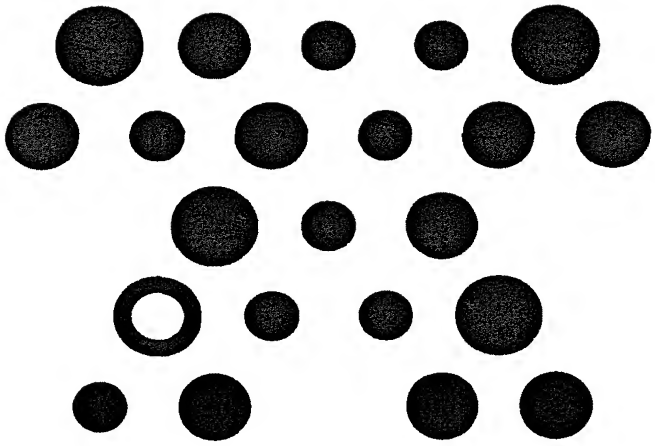

FIG. 10

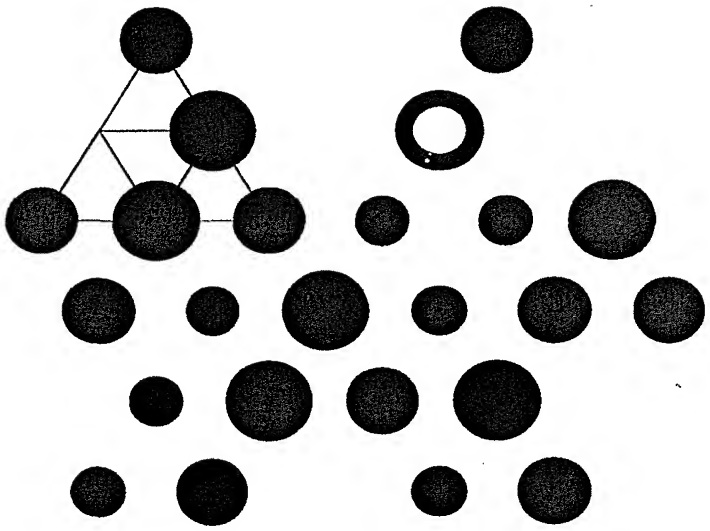

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR01/00671

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G06K 1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)

IPC& G06K, G06F

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched

Korean patents and applications for invention since 1975
Japanese patents and applications for invention since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search trerms used)

KIPONET, USPTO.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP2000-293644A(OMRON CORP) 20 October, 2000 See the whole documents	1-5
A	JP 10-261058A(DAINIPPON PRINTING CO LTD) 29 September, 1998 See the whole documents	1-5
A	JP 11-167602A(MIYACHI TECHNOS CORPORATION) 22 June, 1999 See the Figures	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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Information on patent family members

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